Status of the critically endangered Mauritius Fody *Foudia rubra* in 2001

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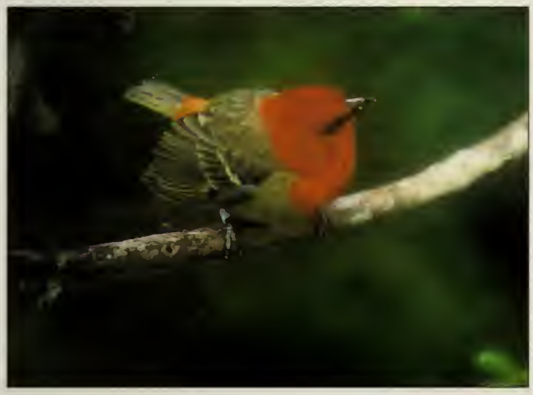
Le Foudi de Maurice *Foudia rubra* est une des neuf espèces d'oiseaux forestiers encore présents sur l'Île Maurice. La population a diminué principalement à cause de la déforestation et de la prédation par des mammifères introduits. Entre 1975 et 1993, les effectifs du foudi sont passés de 260 à 120 couples, ce qui représente une diminution de 55%. En 1998–2001, période de la présente étude, aucun changement dans le nombre d'oiseaux n'a été noté par rapport à 1993. Dans le noyau central de sa distribution, l'espèce a connu une expansion vers le nord, mais une des sous-populations situées en dehors de cette zone a continué à régresser. En 2001, la population entière était concentrée sur moins de 17 km². Entre 1993 et 2001, le nombre de territoires en forêt indigène a diminué de 20%. De nouveaux territoires ont été découverts dans des habitats exclusivement exotiques, ce qui n'avait pas été rapporté auparavant et semble représenter un changement réel ou une augmentation du nombre d'habitats utilisés depuis 1993. Si les populations dans ce genre d'habitat s'avéraient viables, les chances de survie de l'espèce augmenteraient de façon significative, vu le fait que la végétation indigène continue de se dégrader.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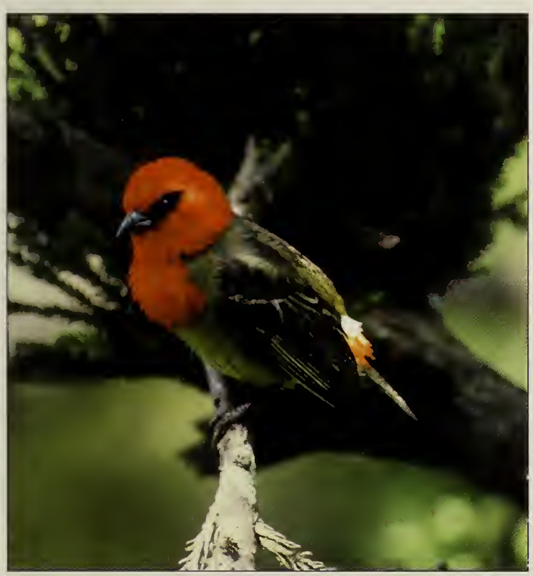
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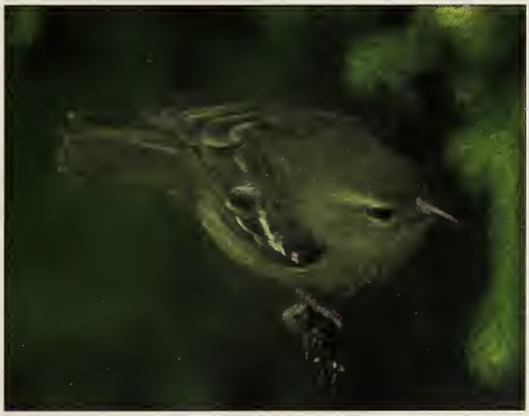
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1–2. Male Mauritius Fody *Foudia rubra*, Pigeon Wood, Mauritius, December 1991 (Roger Safford)

3. Male Mauritius Fody *Foudia rubra* (Nick Garbutt/NHPA)

4. Female Mauritius Fody *Foudia rubra*, Pigeon Wood, Mauritius, December 1991 (Roger Safford)

Introduction

Since the arrival of humans on Mauritius in the 1600s, over half the endemic vertebrate species have become extinct[3]. Only nine endemic bird taxa remain on the island, eight of which are threatened[1,9]. Mauritius Fody *Foudia rubra* is a forest-living weaver. Formerly more abundant throughout the island, the population is now restricted to a small area of south-west Mauritius. Reasons for the decline of Mauritius Fody include large-scale clearance of native habitat, degradation of native ecosystems by introduced plants and animals, and depredation by introduced mammals. Currently, the two main problems are lack of habitat and nest predation[4,9]. At best 5% of native forest remains on Mauritius, most in a very degraded state[10]. Nesting success is extremely poor (c6%) over most of the range, and predation by introduced monkeys *Macaca fascicularis* and rats *Rattus rattus* cause 83–95% of nesting failures[11].

Mauritius Fody is currently classified as Critical[1]. During the first intensive study of Mauritian passerines in 1973–75, the fody was recognised as endangered. Fewer than 260 pairs remained in a small area in the south-west[4]. An attempt was made to introduce Mauritius Fody to Réunion in 1975 but this was unsuccessful[2]. A second census, conducted in 1989–1993, found that both distribution and numbers had decreased by 55%, to 104–120 pairs within a 14.7-km^2 area[9]. From November 1998 to March 2001, the Mauritius Fody population was re-surveyed to determine its current status. This paper reports the findings of that survey.

Methods

Study area

The forest of south-west Mauritius consists mainly of areas of exotic vegetation, degraded native forest and softwood tree plantations (Fig 1). The most common introduced plant species in areas of exotic and degraded native vegetation include *Psidium cattleianum*, *Ligustrum robustum walkeri*, *Ravenala madagascariensis*, *Syzygium jambos* and *Rubus alceifolius*. Six small *Cryptomeria japonica* groves are located between Montagne Cocotte and upper Combo, the largest being a 6-ha area known as Pigeon Wood. Pétrin and Gouly are nature reserves with small areas of native dwarf forest. Tree plantations consist mainly of *Pinus elliotti* and to a lesser extent *Eucalyptus robusta*, with small areas of *Cryptomeria*, *Araucaria* spp and *Callistemon citrinus*. These plantations were established in 1970–75 and replaced a marshy dwarf forest rich in endemic *Pandanus*.

Census technique

Territory mapping permitted direct comparison with the 1993 survey. During the breeding season, which extends from September to March[12], males are very vocal in their territories and 3–4 long visits normally reveal all of the birds[2]. The census was undertaken in November–March 1998–99, and September–March 1999–2000 and 2000–01. Starting with the areas of highest density found by Safford[9], territorial birds were located and their territories mapped. In areas of high density, separate territories could be distinguished by locating disputing individuals or pairs, birds with distinctive markings, and pairs exhibiting nesting behaviour. Distinguishing territorial birds was most effective during dawn chorus (04.30–06.30 hrs). The total number of territories was estimated by extrapolation from the number of territories found and the amount of available habitat in south-west Mauritius.

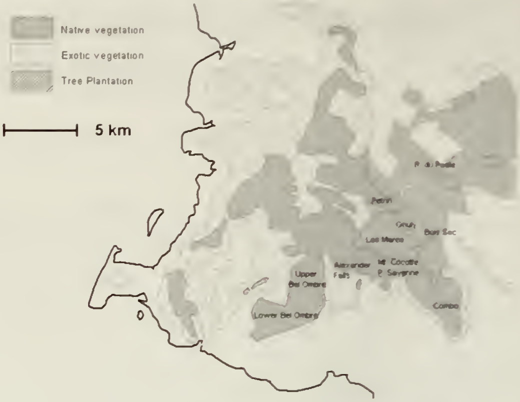

Figure 1. Map of south-west Mauritius with vegetation types and area names referred to in the text (adapted from Safford[1]).

Table 1. Coverage of areas surveyed between 1998 and 2001.

Area	Hours	Effort (hr/km^2)	Assessment of coverage
Rivière du Poste	30	15	Good
Bel Ombre	75	9.4	Good
Pétrin	40	23	Good
Gouly	24	13.3	Good
Alexandra Falls	21	6.8	Fair
Montagne Cocotte–Piton Savanne	180	30	Good
Combo	96	24	Good
Les Mares	176	58.6	Good
Bois Sec	20	7.6	Fair

Coverage

Coverage varied due to the patchy distribution of the population (Table 1). The coverage categories followed those of Safford[9]. Coverage was considered 'good' when total effort in an area exceeded 8 hr/km^2. Any area with effort below this was considered to have received 'fair' coverage. Greater than 75% of pairs were believed to have been located in areas that received good coverage, and at least 50% of pairs were believed to have been found in areas subject to fair coverage. All areas containing the highest fody densities received good coverage. Outlying areas received variable coverage, although most pairs were probably located. No area of suitable habitat was believed to have been missed.

Results

Distribution in 2001

The core Mauritius Fody sub-population occurred between Alexandra Falls and Upper Combo, extending north to Pétrin. Smaller outlying sub-populations occurred at Bel Ombre and Rivière du Poste (Fig 2). The survey located 95 territories, resulting in a total estimated population of 108–122 pairs. See Table 2 for summary.

Population status and structure: 1975 to present

Between 1970 and 1975 extensive areas of native vegetation in south-west Mauritius were felled to make way for tree plantations. Cheke estimated 247–260 pairs of Mauritius Fody in 1975[4], but noted a drastic decline in numbers in 1978. The population was re-estimated at 150–170 after concluding that the high densities recorded in 1975 were an artefact of birds being displaced during forest clearances[2]. From 1975 to 1993 the population declined to between 104 and 120 pairs[9]. The present study found that total numbers have not changed since 1993, with 108–122 pairs estimated in 2001.

The distribution of the Mauritius Fody population has contracted significantly since 1975 (Fig 2). In 1975, the fody's range consisted of a single core area that held over half the total population, and five smaller sub-populations[4]. Since 1975, the distribution has become increasingly concentrated within a single core sub-population. In 2001, more than 90% of the total population was restricted to an area of 15 km^2. The remaining two outlying sub-populations were found within areas of less than 1 km^2 each.

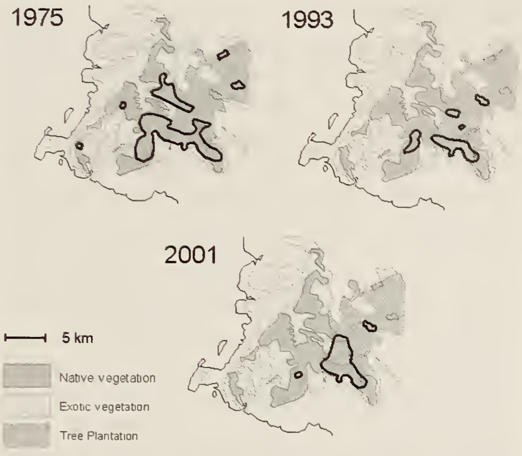

Figure 2. Map of south-west Mauritius showing range of Mauritius Fody *Foudia rubra* (within solid black line) in 1975, 1993 and 2001. Data for 1975 and 1993 are reproduced from Cheke[4] and Safford[9]. In 1975 the small island of native vegetation at Rivière du Poste was not surveyed.

Outlying sub-populations

The number and distribution of territories in Rivière du Poste have remained relatively unchanged since 1993. The Bel Ombre sub-population has shown a consistent decline over the past 25 years. Numbers have decreased from 43 pairs in 1975[2], to 20–25 pairs in 1993[9], and five pairs in 2001. The habitat in Bel Ombre is dominated by degraded native vegetation. Of the 15 territories found in Bel Ombre in 1993, nine were in degraded native forest (which did not include any exotic plantations). None of these nine territories was found in 2001. Bel Ombre contains two small plantations of exotic pine *Pinus elliotti*, each approximately 500 m^2. One plantation is located in Upper Bel Ombre and the other is 2 km to the south. The five Mauritius Fody territories found in Bel Ombre in 2001 were situated around and within the southern plantation of *Pinus elliotti*.

Table 2. Distribution of the Mauritius Fody *Foudia rubra* population in 1992–93 and 2000–01. Data for 1992–93 are from Table 2 in Safford[9].

Area	Pairs found in 1992–93	Pairs estimated in 1992–93	Pairs found in 2000–01	Pairs estimated in 2000–01
Outlying sub-populations				
Rivière du Poste	4	4–5	4	4–5
Bel Ombre	15	20–25	5	5
Core sub-population				
Pétrin	5	5	5	5
Gouly	2	2	2	2
Alexandra Falls	1–4	2–4	3	4–5
Montagne Cocotte–Piton Savanne	55–56	65–72	49	60–65
Combo	4	6–7	4	5–6
Les Mares	0	0	21	21–24
Bois Sec	0	0	2	2–5
Total	86–90	104–120	95	108–122

Core sub-population

The number of territories in Pétrin, Gouly, Alexandra Falls and Combo did not change between 1993 and 2001, although minor shifts in distribution took place. The population between Montagne Cocotte and Piton Savanne appears to have decreased by 5–10% over the same period. The most notable change in the core sub-population has been the expansion north into exotic vegetation. Twenty-one new territories were found in the Les Mares pine plantation. This expansion has linked the birds at Pétrin and Gouly (which in 1993 were isolated sub-populations) to the core population. Les Mares had been recently clear-cut of native vegetation when Cheke surveyed in 1975, and by 1993 still did not support any Mauritius Fody territories[8,9]. The same areas where territories were mapped in 2001 were repeatedly and thoroughly checked in 1993, but no territories were found (R J Safford pers comm). Encouraged by the discovery of the new territories at Les Mares, it was decided to survey Bois Sec, which had similar habitat. The area surveyed at Bois Sec included the small patch of remaining native forest and extended 500 m into the pine plantation surrounding the native forest. Two fody territories were located in the Bois Sec pine plantation west of the native patch.

Habitat use

Changes in habitat use by Mauritius Fodies are best examined in terms of three main habitat types: (1) exotic tree plantations (dominated by pine but also including *Cryptomeria* and *Eucalyptus*), (2) native forest with exotic tree plantations (either as isolated groves or edges of larger plantations), and (3) native forest without exotic tree plantations. Twenty percent fewer territories were found in native forest without exotic plantations in 2001 than in 1993 (Fig 3), resulting in only 19 pairs remaining in such habitat. The sub-population of Bel Ombre has lost all its territories from native forest without exotic tree plantations. Territories in this habitat type have also disappeared from Montagne Cocotte. The most noticeable change in habitat use has been the influx of pairs into pine plantation at Les Mares. Twenty-four percent of territories were found in exclusively pine habitat (Fig 3). Nine active Mauritius Fody nests were found within the pine plantation of Les Mares. This use of exclusively exotic vegetation has not previously been found, and we are convinced that it represents a genuine shift in habitat use since 1993. There have been no major changes in the percentage of territories found in other habitats.

Discussion

Nest predation by introduced mammals is a major factor limiting bird populations in Mauritius[4,8]. The loss of territories at Bel Ombre and not at Rivière du Poste is probably the result of differential predation rates. The Bel Ombre area consists primarily of degraded native vegetation, whereas Rivière du Poste is a small patch of native vegetation within an extensive tree plantation. Plantation trees are less attractive to nest predators, primarily rats and monkeys, compared with native trees which provide ample fruit and invertebrates, the predators' staple diet. Safford[11] estimated that at least half of the Mauritius Fodies nested in exotic trees where rates of nest predation were lower than in native habitats. Frith[6] found that the Red Forest Fody *F. eminentissima aldabrana* on Aldabra nested in exotic coconut trees due to lower predation rates. It is likely that the territories at Rivière du Poste have persisted because they are

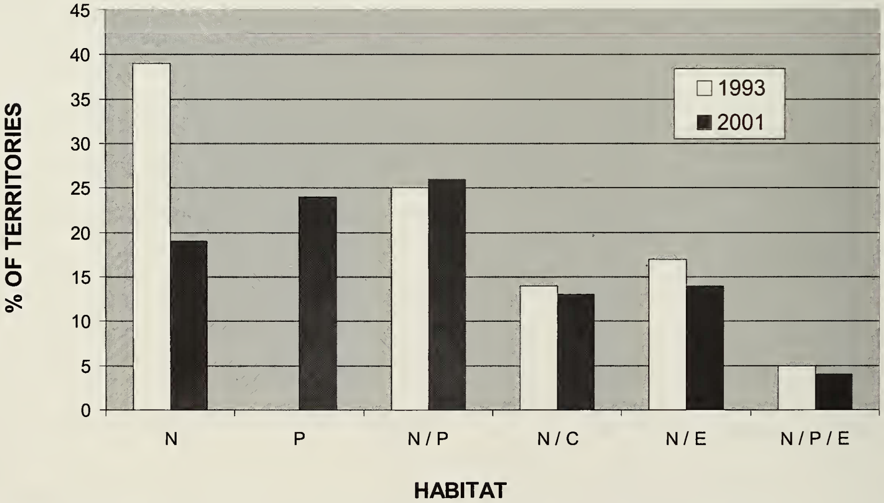

Figure 3. Percentage of Mauritius Fody *Foudia rubra* territories found in Native (N) and *Pinus* (P) forest and in habitats mixed with *Cryptomeria* (C), and *Eucalyptus* (E) in 1993 and 2001. The 1993 figures were determined by referring to territory maps in Safford[8].

centrally located within a large pine plantation. Monkeys have been observed foraging in *Pinus*, but only on a seasonal basis[8]. During the present study, monkey sightings were significantly more numerous in native habitat. On one occasion a group of three monkeys was observed travelling 100 m into the northern pine plantation at Upper Bel Ombre. The pine trees in this plantation were in poor condition, with several open areas that could easily be searched by predators, which may explain why fody territories have disappeared from this area. In contrast, the southern pine plantation at Bel Ombre, where fody territories persisted, had a denser, more uniform area of pine that may be less easily searched by nest predators.

Previously, the use of exotic habitat by Mauritius Fodies only occurred when adjacent native vegetation was available for feeding[7,2]. It was previously noted that native vegetation might not be essential for fodies, provided alternate habitat provided suitable substitutes[4,7]. Observations of fodies probing *Pinus* trees for invertebrates and nectar feeding on *Callistemon citrinus* demonstrate that ample feeding opportunities exist within exotic pine plantations (pers obs)[4,7]. The finding of nine active fody nests at Les Mares confirms that nesting occurs within exclusively exotic habitat (pers obs). This is not unexpected as several other fody species also use exotic habitat for feeding and nesting. Madagascar Red Fody *F. madagascariensis* has been introduced and is common on almost all of the western Indian Ocean islands, where it utilises forest types not present on Madagascar. On Grande Comore, Red Forest Fody *F. eminentissima consobrina* can be found in plantations of introduced coconut, mango and jackfruit[7]. On Rodrigues, where there is very little remaining endemic vegetation, Rodrigues Fody *F. flavicans* inhabits areas of exclusively exotic habitat (pers obs, A Impey pers comm)[4,5].

It is unknown where the birds occupying Les Mares plantation originated, but it is highly unlikely that the new territories belong to birds from the contracting sub-population of Bel Ombre. There has been no large-scale deforestation or any habitat alteration since 1993 to forcibly displace established birds. Mauritius Fody pairs are highly territorial and sedentary[4,12]. It therefore appears most likely that these new territories were established by dispersing juveniles rather than adults.

Safford[13] considered that the population in the core area was highly dependent on birds dispersing from Pigeon Wood. This may still be the most likely scenario. Mauritius Fodies nesting in native vegetation outside Pigeon Wood have had very low nesting success[11]. These may be sink areas where fody mortality exceeds production[13]. Pairs in Pigeon Wood successfully produced more than 30 fledglings annually between 1989 and 1993[8,13]. Pigeon Wood is likely to be the only area with a fody production rate sufficiently high to account for this substantial increase of birds into Les Mares. Birds using pine plantations, such as Les Mares, may also have a comparatively higher nesting success than those in adjacent native forest, as speculated by Safford[11]. This could have important implications for Mauritius Fody populations nesting in plantations but requires confirmation based on productivity studies within plantation areas.

No Mauritius Fodies were found in Les Mares in 1993, yet this area held 20% of the total Mauritius Fody population in 2001. One explanation may be that the trees were unsuitable for nesting or feeding in 1993. However, tree height and canopy cover of the pines has not markedly changed since 1993 (M Allet, National Parks and Conservation Service, Mauritius, pers comm). Invertebrate communities in the plantation may have increased in abundance over time, therefore making the area more suitable for fodies now. Another possibility may be that Mauritius Fodies in Pigeon Wood have fledged more young since the inception of a predator control programme in 1991. Due to the critical status of the endangered Pink Pigeon *Columba mayeri*, a permanent poison grid (using the anticoagulant Brodifacoum) was established in the *Cryptomeria* grove to reduce rat numbers. The rat control programme appears to have benefited the nesting success of the Pink Pigeon (K Swinnerton, Mauritian Wildlife Foundation, pers comm) and may have helped increase fody nesting success.

Conservation requirements

Small, localised populations such as that of the Mauritius Fody are at very high risk of extinction. A new (safeguard) population should be established away from the core area, either in predator-free areas in the wild or in captivity. To achieve this, the following two conservation management techniques should be seriously considered. The first is the translocation of several breeding pairs to areas outside the core population, including offshore islands and/or predator-controlled, fenced mainland areas. The second is to capture and establish several pairs in captivity. Research must immediately commence to learn more concerning husbandry and captive breeding of *Foudia* spp. Preliminary trials of the above techniques should initially be tested on the common *F. madagascariensis*.

Acknowledgements

We thank the Ruth Smart Foundation and United Emirates Natural History Group for financial support of our passerine work on Mauritius. Many thanks for the cooperation and support from Mr Yousouf Mungroo and the staff of the National Parks and Conservation Service. Durrell Wildlife Conservation Trust also provided support. Angela Duffy and Niall McCann

spent many hours searching for fodies, and Dennis Hansen, David Roberts, Thomas Bodey and Kenneth Sutcliffe also assisted with the surveys. Roger Safford provided very helpful comments on drafts of this paper.

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